

~~Electrode Active Material and Methods for Making~~, filed June 20, 2002 and to U.S. Provisional Patent Application Number 60/302131, filed June 29, 2001, the disclosures of which are herein incorporated by reference.

*Please replace the paragraph beginning on line 21, p. 9 with the following replacement paragraph:*

Referring now to FIG. 3, depicted therein is a comparison of various stages of battery life between a hydrogen storage cell without balancing charge (302-308) and one with balancing charge (320-326). Each stage 302-308 and 320-326 shows a positive electrode (p), a negative electrode (n) and the amount of charge from active material in each electrode. The amount of charge is represented by crosshatching and the amount of available capacity is represented without crosshatching. It should be evident from the figure that the charge distribution varies at different stages in battery life. For example, immediately after battery assembly, a cell without balancing 302 is positive limited with a negative charge but no net positive charge from active material, while a cell with balancing ~~348~~ 320 has both a negative precharge and a positive precharge. The cell with balancing also has a net positive charge when comparing the positive and negative active materials. The assembled cells 302, 320 are then subjected to formation.

*Please replace the paragraph beginning on line 3, p. 10 with the following replacement paragraph:*

Formation is used to activate the cell. Formation may be carried out by any process that prepares the negative active material and the positive electrode for routine battery use. Formation may be carried out by heat formation, electrical formation, or

both. Heat formation is the process of heating the cell to prepare it for use. Heat formation operates to activate a battery by removing oxide layers of the negative active material, such as the native oxide layer found in AB.sub.2 or AB.sub.5 hydrogen storage materials, and may also act to dissolve certain additives in the positive electrode, such as Co. Heat formation may also form catalytic regions throughout the surface oxide of certain hydrogen storage alloys, which acts to improve charge and discharge rate capability. Heat formation may be carried out by heating a cell at about 60.degree. C. for about five days or less, and more preferably two days or less. The conditions of temperature and time may, of course, vary depending upon the active materials used and the additives of both the negative electrode and positive electrode. In the cell without balancing 304, heat formation results in a unbalanced charge distribution between the negative and positive electrodes. This unbalanced charge distribution results in a corresponding reduction in overcharge reservoir. Sources of the unbalanced charge distribution include irreversible oxidation of Co-containing additives in the positive electrode; oxidation of newly formed negative electrode surfaces; formation of higher oxidation .gamma.-state positive active material; oxidation of the separator, etc. Much of the increase in negative charged material, if not all, becomes wasted material 310. During overcharge 308, the overcharge reservoir may become depleted and the negative electrode fully charged. With further charging, the negative electrode starts to release hydrogen and increases cell pressure. In comparison, a cell produced with balancing 320 has a positive charge which is substantially the same as the negative charge after heat formation. Balancing provides a cell having a positive precharge (the difference between 322 and 324) in an amount effective to offset, or

substantially offset, the irreversible charging of the negative material during formation and/or during initial cycling. The activated cell 324 is therefore left with a greater available charge capacity than the positive electrode to avoid depletion of the overcharge reservoir. In use and during overcharge, the cell with balancing 426 326 is left with an overcharge reservoir 430 330 in an amount effective for recombining oxygen generated at the positive electrode with hydrogen at the negative electrode to produce water without excessive cell pressure leading to venting.

*Please replace the paragraph beginning on line 9, p. 14 with the following replacement paragraph:*

The preoxidized positive active material is preferably a plurality of partially preoxidized nickel hydroxide particles. The particles preferably have an average particle size of 5 to 50 .mu.m. The preoxidized particles are preferably substantially spherical. Substantially spherical, preoxidized particles with an average particle size of 5 to 50 .mu.m allow formation of pasted positive electrodes having high energy density and increased overcharge reservoir stability. The partially preoxidized particles may include: a solid solution of oxidized and non-oxidized active material; layers of oxidized and non-oxidized material; a heterogeneous microcrystalline mixture of oxidized and non-oxidized active material, or a combination of two or more of the above. As referred to herein, microcrystalline materials have a grain size of 50 to 150 angstroms. Referring now to FIG. 2a, shown therein is a partially oxidized particle 400 200 in accordance with a preferred embodiment. Preferably the partially oxidized particle includes a substantially uniform dispersion of oxidized 404 204 and non-oxidized 402 202 active material. Preoxidized particles that contain a dispersion of oxidized and non-oxidized

material are suitable for delivering a level charge over an extended period of time.

*Please replace the paragraph beginning on line 27, p. 14 with the following replacement paragraph:*

Referring now to FIG. 2b, shown therein is a partially oxidized particle 210 in accordance with another preferred embodiment. The particle preferably has a partially to fully non-oxidized surface 214. The surface 214 is preferably less than 98% oxidized, more preferably less than 50% oxidized, and more preferably 25% or less oxidized. The surface is preferably 3% to 98% non-oxidized, is more preferably 5% to 75% non-oxidized, and most preferably 75% to 95% non-oxidized. A partially non-oxidized surface provides a reduced rate of charge delivery, which has been found to be particularly advantageous during electrode formation where extreme heat may be generated when mixing preoxidized active material with various electrode additives and/or binders. By having a non-oxidized, to partially oxidized surface, excessive heat generation during paste mixing or electrode formation can be alleviated. The non-oxidized surface may also be advantageous in maintaining a higher degree of charge until initial battery cycling has begun. The particle preferably has a partially oxidized bulk and/or core ~~442~~ 212. The bulk and/or core ~~442~~ 212 is preferably 1% to 100% oxidized, more preferably 3% to 35% oxidized, more preferably 5% to 25% oxidized, and more preferably 8% to 20% oxidized. The core may be considered separate from the bulk and oxidized to a different degree than the bulk. The core may therefore be fully oxidized, while the bulk is less than 99% oxidized, or oxidized to a preferred degree as listed above.

*Please replace the paragraph beginning on line 25, p. 15 with the following*

*replacement paragraph:*

The control size-C cell was made from dry compacted negative electrode with transition metal based Laves-phase  $AB_2$  hydrogen storage material, a pasted  $(Ni, Co, Zn)(OH)_2$  positive electrode with 5% Co and 6% CoO additives, 30% KOH as electrolyte, and PP/PE grafted non-woven fabric as separator. The positive electrode was prepared directly from the paste mixture of the virgin (un-oxidized)  $(Ni, Co, Zn)(OH)_2$   $(Ni, Co, Zn)(OH)_2$  spherical powder, Co, CoO, and binder material. The nominal capacity of the cell is 4.5 Ah.